The American Biology Teacher

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National Interest in Science

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Buried Forests of North America

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Cover Photograph

Young Robin. Photograph by John Stemen, Goshen, Indiana, who is Field Auditor for the State of Indiana and enjoys nature photography as an avocation.

THE AMERICAN BIOLOGY TEACHER

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CONSERVATION EDUCATION ASSOCIATION

The Fifth Annual Conference of the Conservation Education Association will be held at the University of Utah, Salt Lake City, Utah, August 18-21, 1958, to develop new ideas for the better teaching of conservation. The theme of the conference will be "Conservation Education at the Grass Roots—How Can We Do It Better." Conference participants will analyze conservation teaching techniques and tools, and will recommend what more is needed at the respective levels. Included in their considerations will be teacher conservation workshops, conservation publications, field trips, charts, posters, films, slides and the like. Governor George D. Clyde of Utah will open the conference. Dr. Stanley D. Mulaik, will be Conference Chairman. Field trips in the surrounding area will be a feature of the conference as well as small group discussions and panels. Here is a chance for teachers interested in conservation instruction to attend a top-level conference, as well as see the sights of the West.

The New National Interest in High School Science

OSCAR RIDDLE
Plant City, Florida

An inspection of high school science by awakened security-conscious outsiders now seems at or near its end. The introspection demanded of all persons associated with secondary education, either in administration or instruction, is just now being precipitately set at a maximum level of need. Possible benefits from the introspection may more than equal those that will actually flow from the external examination. The sputniks and their forebears have eventually engendered a scrutiny that is marvellously late, and almost sure to remain inadequate, hazy and superficial.

The present brief comment is directed to things other than better or right solutions to the many practical problems arising from the now clear compulsion to teach more and better science and mathematics in our high schools. These paragraphs are concerned with aspects of the problem usually slighted or overlooked in current discussion and proposals. Mainly, however, they are prompted by the omitted or hard-to-find emphasis on either the urgency or the capital importance of curriculum revision in almost all discussions of the question.

In much that relates to their newly visualized situation, those who teach the sciences and mathematics in our secondary schools can share satisfactions with teachers of other subjects, indeed with the total high school population; but certain *obligations* are especially theirs. All can profit by an upheaval that might promise somewhat better and more serious education in primary grades, with the possibilities this offers for doing actual high school work in high schools; everyone will welcome promises of increased teacher salaries and more adequate support of the schools; and the numerous proposals for student aid in and beyond the high school can give a lift to student hope and purpose within that school. But, all coeval claims for other subject areas aside, the long overdue *change* that must now be made—compelled alike by our much-threatened national security and by an irrevocable sentence to living our lives in a scientific age—is precisely to begin a more extensive and better teaching of the sciences and mathematics. It is not for something else.

The report of the President's committee on scientists and engineers (December 1, 1957) stated: "There is ample evidence that the Soviet Union is bending every effort to achieve its goal of world domination by leading the way in the scientific revolution . . . . Today Russia has more scientists and engineers than the United States and is graduating more than twice as many each year . . . . The education program of the (this) committee is largely directed to the secondary schools. Not only are the seeds of future career decisions planted during a student's high school days, or even earlier, but the courses he selects and the quality of instruction he receives frequently determine the possibility of his studying for a science or engineering degree in college."

Following a moment of pleased amazement at the transformation implicit in the above quotations—present concern, even alarm, on the part of college and university faculties who were so little sensitive to secondary school affairs much less than twenty years ago—the high school teachers of the sciences and mathematics must fully face their quite unresolved problems and obligations. Only they, apparently, come to grips with an entire series of related circumstances: Most curricula do not now give, and never yet have given, enough *years* to the study of these subjects; the hours of the school day are fixed, and pupil-time added to these pursuits is also subtracted from one or another high school exercise or subject; pupil preference is likely to continue to have much—perhaps decisive—control over the imperative national objective of having a much higher percentage of pupils enrolled in still more of these "difficult" subjects.

One aspect of this item called "pupil preference" goes wholly unrecognized by everyone except some or many teachers of secondary school science. We refer to the conditioning of pupils *against* science by many teachers of the humanities in the high school. This

very material point was adequately documented only recently (Science, April 26, 1957) by a scholar in literature, Joseph Gallant, Roosevelt High School, New York. A few words of his own comment on those facts follow: "To speak in any idiom other than that which incorporates the scientific outlook is to speak the language of the dead. The writer has no choice . . . . History can mold and reenforce the scientific outlook of students. It can attract them to science as a way of life or as a prospective career. Meanwhile the courses in the humanities, on the secondary school level, hold the key to the future of our country and of our society. But the humanities sweepingly ignore the role played by scientific insight and thinking in the ideology of our times and disdainfully march on their archaic way as though the atomic and electronic age has not arrived."

To the numerous voices, including those of many scientists, currently expressing *equal* solicitude for accented training in the humanities, we first recommend attention to this antithesis now encountered at the *secondary* level and a full reading of Gallant's long report. Thereafter, they, and all of us, may well read the recent book (What Man May Be) by scientist George R. Harrison to reenforce the usually overlooked view that scientific training, even for non-scientists, provides a sturdy mental discipline which the classics once gave and which is now too often lacking in the school curriculum. This latter item, however, incorporates a warning that the high school offering should be science, not technology. The latter can disseminate itself in trade, advertising, and a dozen other outside avenues; but for science the sole substantial outlet is scholarship, and only school and college can propagate it. It is in biology that the temptation to detours in technology is greatest. This is promoted by the subject's wealth of technologies, by ready pupil interest in them, by the content of many recent textbooks, and by built-in community aversion to much of the core of biological science.

Still another word on science study for pupils looking to non-science careers. Admitting that the slenderized traditional courses in high school science have often proved less than satisfactory to this group in the past, may one now overlook their importance under an enriched science program and the new place of science in basic national problems? A physicist (E. M. Rogers) recently wrote of this need at the college level: "I want to make a strong plea for special science courses—with thorough study and appropriate theory—for the very able student's father, uncle, brother and school board." Here we may find a hint that—quite apart from pressing demands of national security—science itself is insecure, even in an age of science, if or while misunderstood by a nation's leaders —its legislators, writers, scholars, educators. This and preceding paragraphs point to some of the areas in which the introspection of the entire high school fraternity can be both corrective and productive, largely because those areas are left hazy or untouched by all current governmental proposals that would enable us—not Russia—to "lead the way in the scientific revolution."

We now ask: In this probably decisive educational contest with Russia are the effective resources of our menacing opponent adequately gauged by us? Is the temper and tempo of our educational apparatus a match for one that started forty years ago with a nation 70 per cent illiterate and "today has more scientists and engineers than the United States and is graduating more than twice as many each year"? That is the chilling, unsugared question. Mr. Khrushchev has now formally stated (March 1958) that Russia intends to defeat the West through education, industrial production, and other non-military action. Both primary and secondary schools there are already emphasizing science to an extent that no one has yet proposed here. They have established a universal public school curriculum which consists of 41 per cent science and mathematics. There the school operates not five but six days a week, with a longer school day followed by home work. There motivations to a scientific career are conspicuously greater than here, and only there do all competent aspirants have opportunity to attend college—and at state expense. Moreover, for students in all subjects and at all levels there is a carefully implanted incentive to better one's personal status and to build a great Russia; in this, indeed, a sort of game to "overtake" and to "surpass" the United States. There women physicians out-

number men by more than two to one. There every trained person can be put and kept in whatever post the autocratic state elects. There the huge investment in science and in education is quite independent of what the population might wish to pay. Just where do we find warrant for complacency in the strength of our educational armor? Is there doubt that the high school is the center of this problem? At this late hour do we dare doubt that precisely these schools must now make unprecedented, important decisions.

Learning to Live with Radiation

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Jefferson High School, Cedar Rapids, Iowa

Last summer a state fair advertised free foot and dental X-rays for the public. This bit of generosity may have been a dangerous thing for some.

The increasing amounts of nuclear radiation from fallout, research, industrial and medical usage compel us to recognize that we have an additional hazard to live with. Facts demand that we recognize the growing danger of radiation and that we learn to live near its threatening presence.

Radiation from radioactive sources affects living protoplasm. It can burn and kill. It can blast genes and produce mutations. It can disorganize protoplasm by ion pair production.

Some progress toward understanding the nature of the danger can be made in a biology class even without a Geiger counter. We may take advantage of the fact that some pupils coming to us from junior high science classes can demonstrate the manner in which a radioactive source will discharge an electroscope. Other students should do Henry Bequerel's famous experiment permitting rays to darken film. Pupils may reduce exposure by inserting shields and reducing the time factor. They can see the effect of the alpha rays of a luminous watch dial.

Classes who have a Geiger counter or isotopes will find many other desirable activities listed in the government bulletin concerning laboratory experiments with radioisotopes, listed in the bibliography at the end of this article.

A method of attaching two types of covered film to a radioactive plate is explained by a pupil.

Experiment I

Autoradiographs as a Means of Detecting Radiation

Preparation: Secure dental X-ray film or any other film wrapped in black paper to prevent exposure. Secure some source of radiation such as a luminous watch dial, bright orange fiestaware, yellow canary glass, or a radioactive ore or chemical; film developer, fixing solution, trays, and darkroom.

Discussion: How can we know that there is radiation that we can neither see nor feel? How is an X-ray picture taken? How could an object take its own picture (autoradiograph)? How did Henry Becquerel detect radioactive rays?

Procedure: Attach the covered film to the radioactive source with tape. Leave it there three to five days for the rays to effect the emulsion.

Each pupil will need to plan some way of recognizing his own film after it is developed. He must use a key, a wire shaped into his

initial, or something else to act as a partial shield and leave its shape on the film.

Dental X-ray film have lead shields on their backs. So be sure to place the source of radiation and the partial shield in front. Allow pupils to open one or more dental films before exposure to see how they are constructed. You may be able to obtain the films from your dentist for about 50 cents a dozen.

Develop the exposed film in X-ray developer.

Experiment II

Alpha Rays CAN Be Detected

Preparation: Secure a known source of alpha activity, such as a luminous watch dial, some hand lenses or microscopes with low-power magnification. A well darkened room is a necessity. The teacher should plan some oral activity for the five minutes while the pupils' eyes are closed. The teacher and some of her friends should observe evidences of alpha activity at night before attempting it with a class in daylight hours.

Discussion: Which rays are most dangerous when they are within the body? Is there some way in which we may see the effect of alpha rays? How would these rays reveal dangerous radioactivity of food or water?

Procedure: The pupils must sit with their eyes closed in a well darkened room for five minutes in order that their eyes will become rested and be able to detect the light flashes when alpha rays strike the phosphorus of the watch dial numbers. Don't let them look sooner or they will become discouraged. After five minutes, pass the lens and the luminous dial numbers around the class. If possible, set up a microscope and focus on one of the dial numbers. Pupils can be led up to the microscope and permitted to open their eyes and view the activity of the radium D source.

"Spinthariscope" and "Geigerscope" are names given to commercial devices which use this method for detecting alpha radiation. Each flash shows the death of a radium D atom on the watch dial and indicates the formation of a new and lighter weight atom. The bright flash was solid matter a moment before you saw it.

In a Geigerscope two flashes per minute is considered normal. Any distinct increase in that rate shows contamination and reveals material too radioactive to be taken into the body.

Pupils wishing to build their own spinthariscopes should refer to *Experiments with Atomics*, chapter 5, which is listed in the bibliography.

The teacher may suggest the ionizing effect of radiation on protoplasm in this manner:

1. Secure two identical large colored pictures or well-illustrated pages of advertising.
2. Display one to symbolize the normal pleasing arrangement of electrically balanced molecules in our bodies.
3. Mutilate and display the duplicate copy to show how rays break molecules into positively and negatively charged particles or ions. Tape pieces of the picture back in different positions. Invert one, reverse another, and move a few others. An eye may be staring out of the cheek or neck. Thus we may show how ions come back together in a haphazard manner after being produced by exposure to ionizing rays.

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What You Should Know About Biological Warfare, Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 10 cents.

Chubb, L. W., *The World Within the Atom*, Westinghouse Electric Corporation, 306 Fourth Avenue, Pittsburgh 3, Pennsylvania. Free.

Beeler, Nelson and Branley, *Experiments with Atomics*, Thomas Crowell Co., New York, 1954.

Books for Biologists

CYTOLOGY AND CYTOGENETICS, Carl P. Swanson, 596, $10.00, Prentice-Hall, Inc., New York, N. Y., 1957.

Here is a unified account of the advances made in cytology and cytogenetics with particular emphasis upon the structure of the chromosome as revealed by recombination, position effects, and pseudoallelism; deviations from normal cell divisions; the chemical basis of heredity revealed by recent discoveries; the recombination of genes that takes place in viruses, bacteria, fungi, and higher forms; and evaluation of organisms as reflected in changes in the genome, sex-determining mechanisms, ploidy, and asexual reproduction. (Continued on page 156)

Construction of a Model of DNA

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Since there is such compelling evidence that DNA (deoxyribonucleic acid) is the chemical entity responsible for the transmission of hereditary characteristics, a study of DNA has an important place in a genetics class. A student must be able to picture this molecule as a three-dimensional structure before he can evaluate the extent to which it meets the theoretical requirements of a gene: self-duplication and transmission of information. This paper describes two ways to construct an inexpensive model of the DNA molecule which should overcome some of the inadequacies of a two-dimensional representation.

The DNA molecule, according to the structure proposed by Watson and Crick (1953), consists of two polynucleotide chains forming a double helix around a common axis. The sugar-phosphate backbones of these chains are joined by pairs of purine and pyrimidine bases at right angles to the axis of the helix. The bases are complementary and are joined by hydrogen bonds. Guanine and cytosine are joined; adenine and thymine are joined. The symmetry of the molecule depends upon the proper pairing of the base groups involved. The dimensions of the DNA molecule, as described by Watson and Crick, are shown in Figure 1 in angstrom units (.0000001 mm.). The pairs of bases are 3.4 A apart, and there are ten pairs of bases in each turn of a helix.

A firm plastic tube, ordinarily used to display bird skins, makes an excellent transparent form upon which to construct the model. Suitable tubes are sold by biological supply houses. Various sizes can be used, but one 8.5 cm. in diameter has been used successfully. So that directions given here can be used with tubes of various sizes, the dimensions shown in Figure 1 have been reduced to multiples of the diameter of the tube.

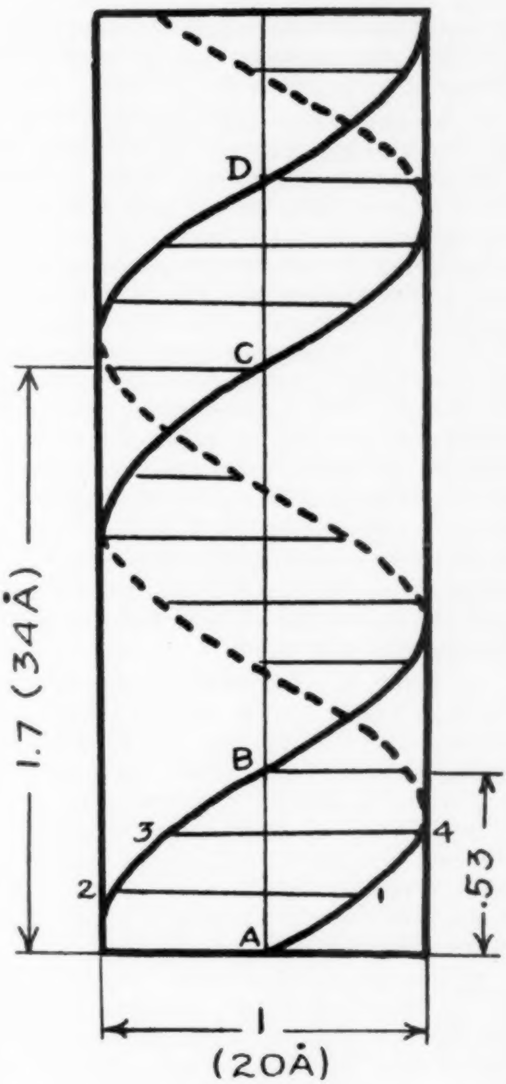

FIGURE 1.

Holes were punched in the plastic with a needle, using an eraser for backing, at points A, B, C, and D along the seam of the tube. A tight string circling the tube and stretching from A to C established the slope of the helix. Another helix was laid out parallel to the first between points B and D as shown in the diagram. Holes were made along each helix, dividing the distance into ten equal parts. After

[1]The author is grateful to Dr. Norman H. Giles of Yale University and his colleague, Dr. Chester Partridge, for their critical review of this paper and their valuable suggestions.

the first turn of the helix was laid out, the pattern was repeated along the tube.

The helices can be laid out with greater accuracy if a paper pattern is made first. A right triangle with one side equal to the circumference of the tube and the other 1.7 times the diameter (A-C in Fig. 1) can be wrapped around the tube and fastened temporarily with masking tape to indicate the proper slope for the helix.

Base pairs can be represented by colored plastic soda straws cut to size. The writer used red straws and yellow straws. The red straws were painted white on one end; the yellow straws were painted blue on one end. Thus adenine and thymine were represented by red and white; guanine and cytosine were represented by yellow and blue. The straws were "sewed" into place in a random sequence in such a way as to be parallel with the bottom of the tube. The threaded needle was passed through hole 1 (Fig. 1), through a straw and out through hole 2. It then was passed through hole 3, through a straw, out through hole 4, etc.

Plastic tape was attached along both helices to represent the chains of deoxyribose sugar and phosphates and to hide the thread supporting the soda straws.

A useful, but less satisfactory model can be made from a mailing tube. A paper cut to wrap around the tube exactly can be laid out as shown in Figure 2. When this is properly colored to indicate the sugar-phosphate chains and the pairs of base groups, it should be fastened around the tube with cellophane tape. While this model is easier to make, it lacks many of the advantages of the transparent model.

The references given below will be helpful to the instructor as he constructs the model and as he studies the analogies between the model and the current conception of the DNA molecule. They will suggest how this model can be used to study the question of the duplication of the DNA molecule, how the molecule might encode information, and other important points.

This model, resting on an instructor's desk is excellent "question-bait." It is quite possible that the unsuspecting student who asks about it will find himself so interested in the answer as to want to know more about the subject.

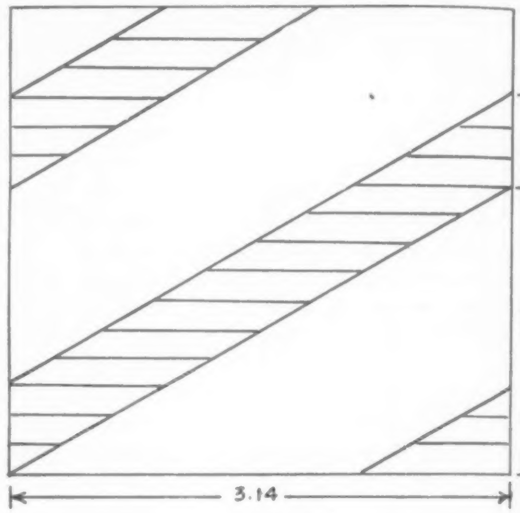

FIGURE 2.

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Books

(Continued from page 154)

NEW DIRECTIONS IN SCIENCE TEACHING, Anita D. Laton and S. Ralph Powers, 164 pp., $2.50, McGraw-Hill Book Co., Inc., New York, New York, 1949.

This book describes and interprets the experiences of a group of teachers who applied current educational theory to the education of youth in senior high school. It presents accounts of what alert, forward-looking teachers have done under regular classroom conditions.

LIGHT, VEGETATION, AND CHLOROPHYLL, J. Terrien, G. Truffant, and J. Carles, 228 pp., $6.00, Philosophical Library, New York, New York, 1957.

This is a useful exposition of present-day knowledge of photosynthesis in two parts—the first work dealing with the nature of light as a form of energy and the light requirement of plants in different parts of the world and under different climatic conditions, the second work dealing largely with the chemistry of chlorophyll and photosynthesis.

(Continued on page 162)

Some Observations of the Nesting Habits of the Eastern Phoebe

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The eastern phoebe (*Sayornis phoebe*) is an unpretentious, drably colored bird, which does not ordinarily attract attention to itself. Its nesting habits, however, are very interesting, and this paper is an account of observations made on a pair of the species throughout one nesting cycle. The study was conducted at the Forestry and Biological Station of the University of Minnesota, which is located in Itasca State Park in northwestern Minnesota.

Like seventeen other phoebe nests observed in the park, this one was constructed of mud reinforced with fine grasses and lichens, and lined with down. Like the others, it was statant and adherent to a man-made structure. This particular nest was located on a ledge above the door of a cabin occupied by the writer and his family during a five-week period.

The nest was under construction when first observed, and its progress was noted until completed two days later. A blind was prepared at a safe distance, so that the nesting and succeeding activities could be studied without unduly disturbing the birds. Phoebes tolerate some degree of molestation by humans in spite of the fact that they appear timid and flighty. Ordinary passage through the door beneath the nest occasionally flushed the occupants, but only temporarily interrupted their activities.

The interior of the nest and its contents were periodically examined with a piece of broken mirror that was attached to a yard stick in such a way that observation was possible from beneath. Such examinations were made when the nest was unoccupied by the adults. In this manner one pure white egg was found the morning after the nest was completed. Neither parent was observed in attendance during the daylight hours which followed, but the mother spent the ensuing night on the nest. Two days elapsed before a second egg was noted, and on each of the three succeeding mornings another was deposited, until a total of five were present.

Incubation commenced immediately, with the female taking complete charge. The male spent considerable time sitting on a nearby clothesline and chirping a two-syllabled song. He would also bring food to the female during the day. It was not known where he spent the nights, but he would make his appearance at dawn.

Sixteen days elapsed before the first egg hatched, and within three more days all but one had opened. The fifth did not hatch and was expelled from the nest several days later.

It was decided to observe feeding activities and obtain information regarding trips to the nest, possible sources of food and other movements from the time of hatching until the fledglings left home. A time schedule was planned so that observations would be made for one hour each day. These periods were so planned that activities were noted during different hours of each day. For example, on the first day the birds were watched during the first hour of activity in the morning, the second day on the second hour and so on until the end of the cycle. Records of trips to the nest were kept to get some idea of maximum and minimum activitiy. One entire day was devoted to making a complete check from pre-dawn to the cessation of activities at dusk. In addition to these periods, frequent observations were made during irregular times by the writer and members of his family.

The first observation after the young were hatched indicated that the male took no part in feeding the young directly but would pass the insects to the female and she in turn would feed the nestlings. She would also leave the nest periodically to collect food. Most of the insects were captured on the lawn near the cabin and in a tall grassy area toward the east. The prey brought in at this time was small enough to be carried within the mouth. The female was repeatedly seen to fly to a spot about twenty rods southward, where she would drop to the ground, remain a short

time and return. Fifteen such trips were made by her during an hour of observation. Although dragonflies were very plentiful, some flying within just a few feet from the nest, none of these were caught at this time.

An unusual procedure was noted on the next day. The male was seen flying toward the nest with a large cricket in his bill. He hovered momentarily in the air near it, then dropped to a concrete stoop under the nest, and with deliberate, slashing movements thrust the insect repeatedly against the concrete. After about a dozen such movements, his prey was picked up and taken to the nest. This was thought to be a tenderizing process, and repetitions of it were observed many times on the following days.

It was also noted that wastes were carried out on this day, and as the removal of wastes was a new experience, it was concluded after research that the mother must have eaten the feces during the previous days. (Wallace, 1955)

Both parents were not seen in the nest at the same time, although the male would occasionally perch on the rim while the female was within it. The father was observed to make his entries from the west and the mother from the east throughout the entire observation period. The female generally made direct flights to the nest, but the male invariably would land upon the nearby clothesline first, and make his entries from there. The insects were not captured in the same places by the two adults, each having its own restricted collecting territory.

On the following day the observer noticed the dead body of one of the nestlings on the concrete under the nest. It was not determined if it had accidently fallen, or if it had been deliberately pushed out. A glimpse into the nest showed three occupants still remaining. There was a bluish downlike body covering except on the wings and tails. The eyes were not yet fully open. The nest was clean and no droppings were seen on the concrete beneath. Feeding activities had speeded, as twenty-nine trips were counted during one hour of watching.

On the ninth day after the last egg hatched, it was decided that an entire day would be devoted to observation. The observer rose at 3:35 in the morning. At 4:12, before the sun

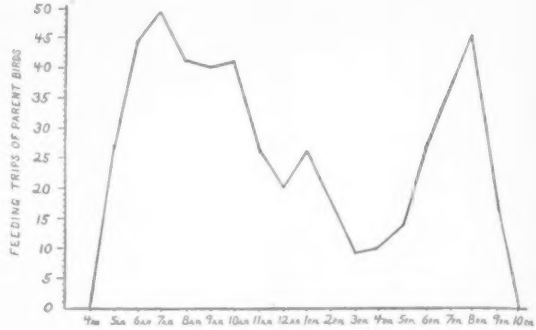

FIGURE 1. Feeding Record

was above the horizon, the female left the nest and flew out to a distance of about thirty yards. Without hesitation, she circled in flight and returned to the nest. The same course was followed nine consecutive times, and the writer was at a loss to explain this phenomenon. Later it was learned that this was apparently done to remove the accumulated wastes of the previous night. The male entered the scene at 4:20 A.M. by landing on his favorite perch near the nest. His monotonous two-syllabled call was again heard, and he twitched his tail vigorously from side to side, as is characteristic for the species. Within several minutes he was seen to collect insects and take them to the nest.

All feeding trips by both birds were counted and recorded. A total was kept for each hour of the working day. The accompanying graph shows the number of such trips made to the nest by the parents during the day. No separate record was kept on each bird, but the numbers given represent the trips in totals for both adults. It will be noted that there were two high points of feeding, one between 6:00 and 7:00 A.M. and another between 7:00 and 8:00 P.M.

Figure 1. Feeding activities of pair of eastern phoebes, during an eighteen hour period as determined by one observer. University of Minnesota Forestry and Biological Station, Lake Itasca, Minnesota.

During the succeeding days, feeding activities were gradually speeded up, larger insects were collected and in the final days no attempt was made to tenderize them before feeding the young. As time went on droppings were noted on the concrete below the nest. Apparently the young had learned to deposit them over the sides, leaving the nest clean. Periodic examinations showed an increased

feather development. The flight feathers seemed fully formed, and the down had been replaced by contour feathers, making the young appear as large as the adults. The heads of the young bobbed vigorously above the rim of the nest when the adults came near. Bringing the mirror over the young to observe them resulted in a similar reaction.

On the sixteenth day after the first egg hatched, there was an unusual amount of commotion and activity, and there was little feeding done. Shortly after the observation period started, one of the restless young mounted the rim of the nest, and fluttered its wings vigorously. It appeared to be preparing for flight. The same thing was repeated several times, and finally in an awkward falling flight it landed on the lawn some distance from the nest. There were several short hops of this kind toward the tall grass area, with both parents in pursuit. The male followed the young fledgling, but the female soon resumed her duties at the nest and spent the night with the remaining young.

The following day was another busy one for the brood. Both parents were about, but the adventuresome one of the previous day was not seen. A second nestling attempted to leave home on this day, but was not as successful in its take-off as the first. Its foot became entangled in the nesting material, and it could not free itself. It hung there until released by the observer and returned to the nest.

Within the hour another attempt was made and several minutes later all occupants had abandoned the nest and were seen fluttering about the premises during the remainder of the day.

The nest was closely observed for the next several days, to see if another nesting cycle would be entered upon. On a rainy afternoon sometime later sounds were heard from the abandoned nest. An investigation showed that instead of the phoebes as was expected, an adult wren had somehow managed to take refuge with her brood of fledglings in the nest. The night was spent on the nest, but early morning brought complete abandonment again. Neither the phoebes nor the wrens returned again, and the brood which was so carefully observed during the previous weeks, was not seen in the vicinity again.

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Bats in the Bell-Jar

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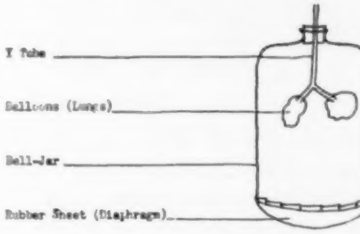

FIGURE 1.

Most biology teachers are probably familiar with the bell-jar demonstration of diaphragmatic breathing. *The General Science Handbook* (Part I), issued by the Bureau of Curriculum Development, Division of Secondary Education, New York State Education Department, Albany, New York, 1951, pages 44 and 45, shows the diagram and textual explanation in Figure 1. "Lowering the diaphragm reduces the pressure inside the chest cavity and air flows into lungs. Raising the diaphragm reverses the flow of air." (page 44)

Unfortunately, however, these oft-repeated references to the bell-jar apparatus are grossly inaccurate and should not be used except with extreme caution and adequate explanation.

Students should be instructed in the double process involved in breathing: (1) diaphragmatic breathing, as well as (2) costal breathing, in which the ribs move up and out to increase the volume of and reduce the pressure in the thoracic cavity.

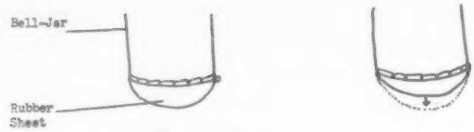

FIGURE 2.

FIGURE 3.

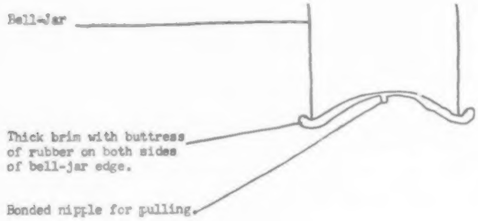

FIGURE 4.

There are two main objections to the bell-jar apparatus. One, the diaphragm does not, in fact, move in the manner demonstrated. The diaphragm according to the bell-jar set-up moves from an inverted dome to an even lower position than the meniscus of the inverted dome, as shown in Figure 2. When, in fact, in the body the diaphragm moves from a dome position as shown in Figure 3.

Two, the diaphragm itself as a tissue would appear to *stretch* according to the bell-jar demonstration. Actually, however, the diaphragm *contracts* from a large surface area as a dome to a smaller area as a horizontal plate.

An alternative to the rubber sheet, used with the bell-jar, would be a rubber derby with a Homburg brim. The brim would curve up and be especially thick, and the center of the crown would have a small nipple suitable for pulling the diaphragm down. The rubber hat would appear as shown in Figure 4.

In operation, the two edges of the brim into which the bell-jar fits would be quite close together. When the bell-jar is set into the diaphragm, there will be a tight fit. A steel tension band could also be used to circle the bell-jar and make close contact with the diaphragm. The nipple would be pulled down, bringing the dome to a horizontal position, which would inflate the "lungs."

This apparatus would give a more nearly life-like reproduction of diaphragmatic breathing. However, the teacher would still be obliged to call attention to the action of the ribs in costal breathing.

Disease in Laboratory Frogs and Turtles

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The care of the animals and control of their diseases are vexatious problems in any active biological laboratory, and much research has been directed to these problems. The quarterly journal called the "Proceedings of the Animal Care Panel" is especially recommended to the interested reader. Frogs and turtles particularly are used in enormous numbers in teaching and research, and because of the prevalence of diseases in these forms, pertinent studies have been undertaken in many laboratories including our own. A general conception of current management of these animals will be outlined.

It is advisable wherever possible to use only one species of frogs or turtles. This facilitates homogeneity of any research data and provides familiarity with the animals' habits, properties and diseases. We use *Rana pipiens* (grassfrogs) and species of *Pseudemys* (*aquatic terrapins*). These animals are hardy, manageable, adequately long-lived, and procurable at all seasons commercially throughout the country.

Both *Rana* and *Pseudemys* can be stored at approximately 6° C. Frogs are placed in rectangular plastic mouse cages (Keystone Plastics Co., Swarthmore, Pa.) with perforated stainless steel covers, which are stacked in a refrigerator. The cages are scrubbed with a detergent on alternate days, then rinsed in water and kept moist by adding a few ice cubes. Feeding is unnecessary because of low metabolism, and disease transmission is minimized. Keeping only a few frogs to a cage gives additional prophylaxis.

Turtles are preferably held in artificial hi-

bernation in a coldroom, with no feeding and minimal care. The surface of the holding tank should be dry at one end and slope down to circulating shallow water at the other. If feeding is necessary with storage at higher temperatures, canned chopped horsemeat, crushed bananas and lettuce, plus addition of a few drops of cod-liver oil are adequate. Feeding is done on alternate days under clean water in separate tanks.

A healthy turtle has clear eyes, a firm shell, good muscle tone, and lifts his body when walking with the tail stretched horizontally. The usual trouble is dietary. The eyes are inflamed and the shell is softened. Supply fresh food, and give calcium through crushed chicken bones, plaster of Paris, or other means. Sunlight is important and a partial substitute in dark rooms is ultraviolet irradiation from a sunlamp.

Turtles are parasitized by all major classes of protozoans. The relationship of these parasites to a definite disease is mostly speculative. Turtles also are commonly infested with trematodes and nematodes, and occasionally with cestodes. Bot-flies and ticks among the arthropods produce injury through burrowing and bites. Among plants, some fungi produce eye sores, and algal epizoites may cause skin decay. Species of *Clostridia* and *Salmonellae* among the bacteria can produce fatal septicemia.

We find a very common bacterial disease to be a fatal blood infection, characterized visibly by cutaneous ulcerations on the soft tissues, muscle flaccidity and general apathy. The red blood cells are vacuolated and destroyed. Many of the visceral organs show gross lesions and progressive destruction. The pathogen is *Escherichia freundii*. It is isolated from the cutaneous and internal lesions and also from the blood. The disease is naturally transmissible into frogs and experimentally transmissible into mammals. Treatment is usually successful with chloramphenicol, injected intraperitoneally in an initial dose of 6 mg per 100 gm of soft tissue weight, followed by 3 mg (in one ml) per 100 gm for at least five days. In computing dosage subtract about 28 per cent of the total weight to eliminate the relatively inert shell weight.

Where turtles are used for experimental procedures, anesthesia may be advisable. Nembutal induces deep anesthesia in one-half to one hour. It can be injected intraperitoneally (thrusting the needle into the body cavity from between the hind leg and tail), or into the heart (thrusting the needle caudally along the side of the neck), in a single dose of approximately 16 mg per kg of total body weight. The animals remain in surgical anesthesia several hours.

Frogs just received should be rinsed in clean, cold, running water, and examined for cutaneous hemorrhages, swelling, listlessness and decreased pigmentation, all of which suggest disease. Affected animals should be isolated. Storage containers should be disinfected after each lot of frogs is used, and then rinsed thoroughly in water.

In cool climates and where feeding is done, frogs are held at room temperature in tanks cleaned with continuously flowing water. Toxic skin secretions are washed away. A shallow resting area is needed at one end, while deeper water that is varied with a standpipe should flow at the other end.

We have found that chloride of lime, phenol and Novosan (Nova Products, Inc., Kansas City, Mo.) can sterilize empty frog tanks infected with common frog pathogens when the drugs are used in concentrations above 2.0, 0.5 and 0.5 per cent, respectively. Copper sulfate, formalin, tricresol, mercuric chloride, and potassium permanganate are effective in concentrations not under 0.1, 0.01, 0.01, 0.002, and 0.001, respectively, to sterilize empty tanks, nor over 1.2, 0.06, 0.4, 0.008, and 0.1 per cent, respectively, with frogs immersed for about one hour. Sodium chloride solutions are worthless.

Feeding frogs is laborious. Living insects or else such food as beef or liver waved before the animals with forceps is satisfactory. Despite the best care, frogs vary in health and resistance with the seasons. Studies here show that they develop an anemia in the spawning season, which is apparently constitutional and independent of any controlled environment.

Frogs are parasitized by a great variety of plant and animal pathogens. Protozoans and helminths are the major animal invaders, but acanthocephalans, annelids and arthropods are occasionally involved. Fungi are found usually as secondary invaders in the weakened animal. It is surprising how frequently a frog

adapts itself to potential pathogens, and overtly manifests little or no signs of disease. This fact assumes experimental significance in speaking of "normal" frogs.

The major pathology of frogs is red leg disease, an infectious hemorrhagic septicemia caused by a bacillus, *Pseudomonas hydrophila.* Warm, stagnant water and crowding facilitate infections, especially in the spawning season. Transmission occurs in water through the abraded skin. The animals become listless, pigmentation lightens, cutaneous red spots appear and the abdomen and thighs are swollen with edema fluid. The red cells are vacuolated and reduced in number, while the granulocytic white cells become destroyed.

Control of red leg disease lies essentially in prophylaxis since treatment is successful only in the early stages. Chloramphenicol is usually effective, given by injection or by oral intubation in doses of about 3 mg per 100 gm body weight twice daily for five days. Dissolve the drug in distilled water such that one ml of the initial dose contains 5 mg while one ml of the succeeding doses contains 3 mg. Treat all suspected frogs routinely. Tanks may be disinfected as described above. We occasionally let the frogs swim freely in the permanganate solution.

Frogs are readily anesthetized with ether for experimental use. Put the animal under a beaker in which there is placed a wad of cotton moistened with ether. Avoid excess ether, and carefully observe the decrease in the rate or respiration and in bodily movements.

Books

(Continued from page 156)

OF MEN AND MARSHES, Paul L. Errington. The Macmillan Co., New York. 150 pp. illus. 1957. $4.50.

Teachers should welcome the opportunity to share the observations of a skilled biologist who has made the winter marsh a part of his own life. Dr. Errington's technical works on such topics as muskrat population trends and the nature of predation pressure are well known. But in *Of Men and Marshes* he looks up from his statistics to share an intimate understanding of wild animal ways with both layman and biologist.

Against a background of ecological concepts that are neglected in most biology texts, he reveals marsh life through the sequence of the seasons. He compares the glacial marshes of his native north-central prairie with those of several other parts of the country. He sounds an alarm about further destruction of our marshes. And without presuming to have an answer to world population problems, he compares muskrats and men in a way that should interest sociologists as well as biologists.

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SCIENTIFIC CAREERS AND VOCATIONAL DEVELOPMENT THEORY, Donald E. Super and Paul B. Bachrach, 135 pp., $1.00, Bureau of Publications, Columbia University, New York, New York, 1957.

This monograph summarizes what research has shown to be the characteristics of natural scientists, mathematicians and engineers. It evaluates the methods and outcomes of the studies reviewed in the light of current vocational development theory.

LIVES IN SCIENCE, Scientific American Magazine, 274 pp., $1.45, Simon and Schuster, New York, New York, 1957.

A book of 18 biographies of two or three authentic giants, a hero or two, a saint and a rascal, sunny men of action and sour recluses and a selection of eccentrics, prodigies and sages —all brought together because they lived their lives in science.

PSYCHOPATHIC PERSONALITIES, Harold Palmer, M.D., 179 pp., $4.75, 1957.

A study of the nature and character of the major mental disturbances, particularly schizophrenia and the manic-depression psychoses, by a leading British psychiatrist. There are chapters on psychopathic personalities, schizophrenia, the depressive states, obsessions, hysteria, epilepsies, tension syndromes, and paranoid states. Suggested treatments or discussion of treatment is given in each case.

ELEMENTS OF ECOLOGY, George L. Clarke, 534 pp., $7.50, John Wiley and Sons, Inc., New York 16, N. Y., 1954.

Elements of Ecology deals with the ecological interrelations of both plants and animals, and with the aquatic as well as the terrestrial environment. Lucid descriptions, abo ut 200 illustrations, graphs, diagram,s and photographs, augment the discussion.

(Continued on page 170)

Teaching Ecology in High School Biology*

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In the discussion of this topic there are certain basic assumptions that are pertinent.

1. High school biology is primarily for the purposes of general education for all high-school youth.

2. "The ecological approach to biology teaching is the general education approach."[1]

3. High school biology is an integrated subject including concepts from many areas of the biological sciences.

4. "The most fundamental contribution of ecology to education is it integrative function."[2]

The reasons for teaching the facts and principles of ecology in high school biology are implied in these assumptions. These reasons have been elaborated in considerable detail in the various papers that have been published in the *American Biology Teacher* since 1946 (see bibliography).

Ecology is such a vast subject that the teacher of high school biology is certain to ask, "What particular principles of ecology should I include in my course?"

An examination of current textbooks will reveal that all include some ecological material. Many do not use the word ecology; other profess the "ecological approach." It is likely that most teachers are presenting some ecological material even though some may not use this designation.

For the teacher who desires a deliberate and conscious presentation of ecological material, I would like to suggest that it be selected from the following:[3]

I. Study of local habitats as examples of communities
    A. Types of local communities such as prairie, forest, swamp, bog, desert, sand dune, river, lake, pond, and waste land
        1. Structure of communities — layering, zonation
        2. Kinds of flora and fauna
        3. Seasonal changes
            a. In environment
            b. In species populations
    B. Examples of community succession
        1. Successional stages found locally
        2. Concept of climax
    C. Metabolism
        1. Plants as producers
        2. Animals as consumers
        3. Interdependence — food chains and webs
        4. Saprophytes and parasites
    D. Geographical distribution of typical communities

II. Study of environmental factors and their effect upon organisms
    A. Temperature, light, water, gases, soil, etc.
    B. Plant and animal adaptations to environmental factors

III. Species ecology: Field and laboratory study of life histories of typical organisms found locally

IV. Practical applications of ecology[4]
    A. Conservation and management of natural resources, especially those of the local area
        1. Local agricultural practices, including soil conservation
        2. Forests
        3. Grazing lands

*Paper presented at the annual meeting of the National Association of Biology Teachers at Indianapolis, December 27, 1957.

[1]"Report of the Southeastern Conference on Biology Teaching," *American Biology Teacher*, 17 (Jan. 1955) 24.

[2]*Ibid.*

[3]It is impossible to offer one's own ideas without some duplication of what others have previously suggested. For an excellent treatment on the subject read Aikman, *American Biology Teacher*, March 1947. Furthermore, detailed statements of principles would make this unnecessarily long.

[4]See *Ecology*, 38(Jan. 1957) for excellent articles on applications of ecology in forest management, range management, wildlife management, wildland soil management, and public health.

4. Ponds, lakes, and streams
5. Wildlife management

B. Public health and welfare
1. Pollution problems
2. Pest control
3. Control of disease carriers.

In the preceding outline I have emphasized the understanding of the community as a whole. This is important for all our youth. As Fairfield Osborn has said, "The present reader will carry away with him an enduring conviction that the basic principals and laws governing the entire living community must be generally understood if we human beings are to be successful in maintaining the productivity of the earth. Nature will not accept ignorance of her laws as an alibi."[5]

Methods of Teaching

A way of introducing ecology to the high school biology class has already been admirably described by Miss Hollenbeck in the *American Biology Teacher* of April, 1956. She tells how she has introduced field studies at the beginning of her course. These were direct outgrowths of real problems that faced the students. In the instance cited, the problem concerned the poor trout fishing in a local stream in spite of regular stocking.

Drawing upon her experience as well as my own, I would like to offer an outline of procedure for using the ecological approach in high school biology.

I. Explore experiences of students for real problems that might be appropriate for investigation in the community (Examples: Poor fishing, stream pollution, city water with bad odor, nearby forest "a mess," laws restricting hunting of certain species.)

II. Take a series of trips to a chosen area to make observations and gather data. The class will come face to face with certain problems:

A. Need to identify plants and animals

B. Need to make measurements of environmental factors

C. Need to solve problems by research
1. In books
2. Consulting experts
3. Reports of experiments by others
4. Laboratory studies of certain organisms to work out life histories

(The areas studied may be revisited year after year, changes observed, new data gathered and preserved.)

III. The original problem will most certainly lead to a desire by the students to explore other areas. The "habitat approach" can be worked into the program. The class can study typical local communities which are examples of marine, aquatic, or terrestrial habitats.

IV. The next logical step is the exploration of the natural resource problems of the community and a study of the application of newly discovered principles to the solution of these problems.

Many methods of presentation will soon find their way into this kind of teaching. The use of the field trip will be basic, but the teacher and students will soon discover a need for textbooks, references, laboratory experiments, visual aids, individual and group projects, group discussion, and parental and community cooperation. The use of the scientific method will come naturally to the students. Interest will be high. No artificial motivation will be needed.

It will take an energetic and resourceful teacher to implement these suggestions. He cannot rely upon the textbook-recitation procedure in the classroom and cook-book exercises in the laboratory.

The importance of the field trip was emphasized by Sears in 1946. "We must see ourselves a part of the landscape about us, dependent upon it and responsible for its continuing health and productiveness. To this end, books and laboratories, no matter how good, are not enough. We must get around and see for ourselves what is going on."[6]

Miss Hollenbeck reports that "High school students are enthusiastic about this kind of biology. They develop a curiosity and interest in living things that they could never get from

[5]Fairfield Osborn in introduction to John H. Storer, *The Web of Life,* (New York, 1954) VI.

[6]Paul B. Sears, "Teaching Ecological Relationships Through Biological Field Trips," *American Biology Teacher*, 8(Feb. 1946) 104.

textbooks alone, and an understanding of interrelationships and fluctuations within a community that can only come from outdoor study."[7]

The high school teacher is certain to ask how he is to become prepared to do all that has been suggested. He will correctly point out that there are so many aspects of ecology that even the professional ecologist cannot expect to be well-trained in all areas. This is very true.

The average teacher with an undergraduate major in biology which includes a reasonable number of field courses and one in general ecology, with an understanding of field trip procedures and other techniques, and with some enthusiasm and a will to try, can certainly undertake to teach by this method. He will gain in knowledge and confidence by experience. He will recognize his need for graduate courses to fill certain gaps. After a few years of effort he will no longer be an average teacher but a master teacher.

We should not let ecology become a "sacred cow"—a concept for slavish worship. However, it can be the skeleton upon which the tissues are arranged, or the warp into which the woof may be woven.

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[7]Irene Hollenbeck, "Ecology at the Beginning of a High School Biology Course," *American Biology Teacher*, 18 (April 1956) 158.

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Structural Variations in Flowers

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I have found the following procedure very helpful in simplifying the teaching of structural variations in flowers.

It is necessary to provide each member of the class with one or several flowers. Even in winter, it is relatively simple to obtain discarded snapdragons and gladioli from a funeral home. At other times in the year a short walk through an abandoned field will enable one to pick buttercups, vetch, chickweed, bluets, wild roses, fireweed, etc. In the spring the blossoms of fruit trees are excellent and so are those of the maples, cherries, willows, poplars and many others.

It is assumed that the parts of a generalized flower are known. Working with a snapdragon the instructor begins by calling attention to the green leaf-like structures at the base of the flower. They are carefully removed, counted, and placed on a blank sheet of paper with the labels:

Sepals, 5, green, small.

Then the corolla is studied. It is composed of two lips with two fused petals in the upper lip and three fused petals in the lower. These two lips are fused at the base. They are uneven in size so that it is possible to divide the corolla into only two *similar* parts one of which is the mirror image of the other. The corolla is then removed by making a slit down one side, placed on the paper and labed thus:

Petals, 5, colored, fused, unlike in form and size, with two similar sides.

Attention is then called to the fact that slender structures are attached on the inside

Snapdragon	*Flower*	
•	*Complete*	(4 sets of floral parts)
	Incomplete	(1 or more sets of floral parts missing)
•	*Perfect*	(pistil and stamens present)
	Imperfect	(pistil or stamens lacking)
	Monocot	(parts in each floral set in 3's or multiples of 3)
•	*Dicot*	(parts in each floral set in 4's or 5's or multiples of these)
	Epigynous	(flower parts seem to arise from top of ovary)
	Perigynous	(petals and stamens fused with calyx and pistil seated in concave receptacle)
•	*Hypogynous*	(flower parts attached below ovary)
	Regular	(parts of each floral set uniform in shape or structure)
•	*Irregular*	(parts of one or more floral sets unlike in shape or structure
	Radially symmetrical	(flower can be divided into three or more similar parts)
•	*Bilaterally symmetrical*	(flower can be divided into only two similar parts, each one a mirror image of the other)
	solitary	*Inflorescence*
	spike	
	raceme	
•	panicle	
	corymb	
	cyme	
	umbel	
	spadix	
	catkin	

of the fused petals at the base. These are the stamens, four in number, with anthers covered with ripe pollen. They are removed and placed on the paper thus:

Stamens, 4.

There remains a structure with an enlarged base, the ovary, to which is attached a long, slender stalk, the style. This is the pistil composed of two carpels completely fused. A cross section through the ovary reveals the two carpels and their union throughout the pistil is evident. The place of attachment of the sepals and united petals is noted to be *below* the ovary.

The findings, elicted by questions addressed

to the class, are summarized under the following headings.

A few sprigs can be circulated to see the position of the flowers on the stem. The ordinary inflorescences are easily identified from simple chalk diagrams or from textbook illustrations.

The same procedure can be repeated using flowers that exhibit different structures. With a little practice the students will succeed in "analyzing" a large variety of blossoms and thus master botanical concepts which are difficult and meaningless when taught theoretically.

At first several flowers should be "analyzed" in the laboratory and the answers checked immediately after each dissection. Vague or erroneous concepts can thus be clarified on the spot. When a test is administered the students' answers, presented in the predetermined order shown above, are easy to check.

Suggestions on Undergraduate Biology Courses

The Committee on Educational Policies of the Division of Biology and Agriculture, National Academy of Sciences-National Research Council, has recently published reports on new approaches to the teaching of systematic botany and parasitism. The studies were prepared (with the aid of a National Science Foundation grant) to test an idea for meeting the recurrent problem of keeping teaching abreast of scientific advances (*American Biology Teacher*, 19:117-118, 1957). One method, the Committee suggested, is to invite an *ad hoc* panel of competent individuals, each an expert in a different branch of a given subject, to redefine course objectives and content. This tactic merely adapts the research symposium to consideration of teaching problems, with the hope of encouraging continuing experimentation and reevaluation in teaching by individual instructors.

Members of each panel found, despite wide initial differences of view, that they could develop interesting new syntheses of content, with suggestions for adaptations to different teaching situations. The botanical report (published in *Plant Science Bulletin*, January, 1958) takes a broad view of systematic biology that should also interest zoologists. The parasitism report (published in *Journal of Parasitology*, February, 1958) looks toward a basic course on the biology of parasitism. More generally, the Committee believes that the reports illustrate the value of the approach and recommends that groups concerned with any biological areas consider the organization of similar *ad hoc* panels to help stimulate reexamination of undergraduate courses. Only the individual faculty member, department and college, the Committee emphasizes, can or should decide what to teach, but others in his field may have ideas useful to him.

A limited number of reprints of two reports are available from the Committee (National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C.).

CONSERVATION BULLETIN

"*Materials for Teaching Conservation and Resource-Use*" a 55-page bulletin has been prepared by the NABT and is now available for 35 cents from Interstate Printers and Publishers, Inc., Danville, Illinois.

The bulletin includes listings of free and inexpensive materials from state and national agencies, selected references, films and film strips, prepared by various members of the Conservation Committee of NABT, according to Dr. Richard L. Weaver of the University of Michigan, chairman of the Committee.

The new materials listed in this bulletin were assembled as the appendix of the *Handbook for Teaching Conservation and Resource-Use*, reprinted in January by the Conservation Committee of the National Association of Biology Teachers. The Conservation Handbook of 500 pages is also available from Interstate Printers and Publishers for $4.50, with educational discounts available to schools and teachers.

VISUAL METHODS IN EDUCATION, Second Edition, W. L. Sumner, 231 pp., $6.00, Philosophical Library, New York, N. Y., 1957.

In the present volume the author has limited himself to *visual methods* in education and the treatment has been that of fundamental principles only.

The Buried Forests of Central North America

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Most people are familiar with the buried forests of the western states which are now represented by extensive areas of petrified wood. These were the once buried forests formed in remote geologic times, most abundant in the Mesozoic. As they grew, the trees were buried by catastrophic events such as floods, earthquakes, and volcanic activity. After being buried, the ground water gradually replaced the wood with silica in the form of opal, chalcedony, agate or jasper. This replacement required millions of years and in many cases is so perfect that the wood can be sectioned and studied microscopically almost as well as the cell structure in trees growing today.

Pleistocene Forests

Not as well known is the area in the midwestern states and southern Canada in which another type of buried forest occurs. However, these are the result of the action of the glacial ice during the Pleistocene Epoch (Ice Age). Throughout parts of Iowa, Wisconsin, Illinois, Indiana, Ohio, and southern Canada, numerous remains of buried forests can be found. They are not as spectacular as those of the west and differ in that the wood is not petrified but retains the actual wood substance, having the appearance of wood that has lain in a modern forest for a number of years (Fig. 1). The wood found in some areas is bright, in others it has changed to a dark brown color.

Less than half a million years ago, the first ice sheet formed and began to creep slowly over the surface of the earth, covering everything in its path with a deep layer of ice and snow. In some areas the ice reached a thickness of 5,000 or more feet. Everywhere the ice advanced, it left its characteristic marks in the bedrock and formed thousands of hill-like features known as moraines. The ice advanced over parts of Europe and Asia as well as parts of North America.

As the ice receded, it deposited a layer of clay and gravelly material called "till" over the area where it had lain. This layer of till often ranged from only a few feet in thickness to several thousand feet.

The Glacial Stages

Four times the ice advanced and receded, each time followed a warm period in which the climate returned to normal. In that warm period, the vegetation and animal life again flourished. These stages of glacial and interglacial periods have been named after a locality as the type exposure and occurred in the following manner (after Thwaites 1946).

1st Glacial Stage .... Nebraskan
Aftonian (interglacial)
2nd Glacial Stage .... Kansan
Yarmouth (interglacial)
3rd Glacial Stage .... Illinoian
Sangamon (interglacial)
4th Glacial Stage ...... Wisconsin
Substage .... Iowan
Peorian (interglacial)
Substage .... Tazewell
Substage .... Cary
Two Creeks (interglacial)
Substage .... Valders
Substage .... Mankato

How long ago did these events take place? Until a few years ago, it was estimated that the entire glacial Epoch was contained in a million-year period. However, recent work with carbon dating and study of deep sea sediments indicates that a much shorter time was required and that the entire period occurred within a span of about 300,000 years. Much of the last major glaciation (Wisconsin) may have occurred within the last 30,000 years (Flint, 1957). However, until much more work has been done, these dates must still be regarded as estimates and are subject to change one way or another.

Forest Beds

Wood from buried forests of the Pleistocene was recognized as far back as 1870, but at that time was usually not generally accepted as such. One of the first buried forests was discovered in northeastern Iowa where the term "forest bed" was applied to vege-

tational remains, including stumps and logs, which are more or less in place in or between layers of till (McGill, 1891). In that area, numerous dug water wells yielded many fragments of wood and logs at depths of 10 to 100 feet. They were mostly coniferous trees, although a number of broad-leaf trees were presumably identified. This forest bed was considered to be of Iowan age (early Wisconsin).

Other forest beds were discovered later. One of the more spectacular beds near Toronto, Canada, contained more than 35 species of trees and woody plants (Coleman, 1895). A species of maple (*Acer pleistocenicum* Penhallow) was identified from these beds and is considered to have become extinct during the Pleistocene. Two separate layers, Don and Scarsboro, both belonging to the same interglacial period (Sangamon) indicates both warm and cool climates in this period as determined by plant and animal remains. The warm period (Don) is now considered to be 2 to 3°C. higher than the climate at present (Flint, 1957).

Another famous buried forest is located at Two Creeks, Wisconsin and was buried by glacial ice about 11,000 years ago. There, on the shore of Lake Michigan, a small forest was present when the lake was much smaller than now. The oldest trees were about 375 years old when the ice readvanced and buried them under a pink clay till. When it was discovered in 1902 by Lawson and later described (Wilson, 1936) many stumps were observed in an upright position and the logs broken from them pointed in a southwesterly direction. Most of the trees in that forest were spruce, although other types were reported.

Forest beds such as those described above are not rare in those areas where the glaciers were present, but once exposed do not last because of the fragile nature of the wood. Forest remains of Wisconsin Age are abundant in certain places, but are rarely exposed and lie buried under many feet of till. Forest remains of Illinoian and Kansan age are less common, and those of Nebraskan age are almost unknown.

Exposures of Pleistocene Forests are usually found in excavations for buildings, dam sites, road cuts, or other similar excavations, and they are almost always filled or covered later

Fig. 1. Part of buried spruce log from Two Creeks, Wisconsin. Age by C14 is 11,200 years B. P. This log is about 6 inches in diameter and has about 200 growth rings.

to prevent erosion and the exposure is lost. Also, even in places where the exposure is not covered again, the elements soon change the appearance of the site from season to season.

Many sites are represented by the presence of layers of peaty soil containing leaves, twigs and roots. Sometimes a buried soil is also present. The relative position and stratigraphic data must be determined by a glacial geologist in order that it may be assigned to one of the glacial or interglacial stages.

The wood which is found in the forest beds is always very wet when excavated and severe collapse of the tissue is frequently experienced upon drying. It is not uncommon to uncover stumps in place with the roots extending into the remains of the original soil horizon and to find wood and roots containing bark. As pointed out before, the wood is not petrified or decomposed and the cell structure is frequently intact.

The trees are usually coniferous, being composed of spruce, larch, hemlock, and other conifers. Few remains of broadleaved trees are found, an exception being the Toronto site where a fairly large number were identified. The lack of broad-leaf plants is unusual but may be due to a natural lack of resistance to decay or other factors.

The glacial ice disappeared not too long ago in some areas. For example, in central Indiana less than 20,000 years ago and in Wisconsin about 11,000 years ago. As new techniques for determining the age of other glacial events are found, the earlier stages of the Illinoisan and Kansan stages may be more accurately known.

At the present time, we may be in one of the warm interglacial stages and it is possible that at sometime in the future another glacial ice sheet may develop as it has done in the past.

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Books

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EXPERIMENTS IN BIOCHEMICAL RESEARCH TECHNIQUES, Robert W. Cowgill, and Arthur B. Pardee, 189 pp., $3.50, John Wiley and Sons, Inc., New York, N.Y. 1957.

This volume brings to the graduate student and to the more advanced investigator many of the valuable research techniques of modern biochemistry. Included are such new tools as radioisotope methods, electrophoresis, paper chromatography, gas chromatography; and also methods used for enzyme isolation, enzyme assay, and the study of intermediary metabolism.

THE ORNITHOLOGISTS' GUIDE, edited by Major-General H.P.W. Hutson, 275 pp. $10.00, Philosophical Library, New York, N. Y., 1956.

His work aims at providing a comprehensive guide to all aspects of bird study, and is written particularly for an international public. Included are: the theory and practice of bird study, survey of the present state of knowledge, descriptions of field techniques, and a regional directory which lists all the important ornithological societies, museums and collections in various overseas countries.

PSYCHICAL RESEARCH, R. C. Johnson, 176 pp., $2.75, Philosophical Library New York, New York, 1956.

This book was written for the ordinary person who would like to understand what psychical research is about and why the author regards its future as of such importance. In para-psychology, the au-

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Biology in the News

Brother H. Charles, F.S.C.

THE SIXTH GRADE TAKES TO THE WOODS, Jerome Ellison, *Sat. Ev. Post*, April 19, 1958, pp. 38-39, 63-68.

What happens during a full-week campout when sixth grade students consult the book of nature instead of texts. The experiences recounted will help others in stimulating interest in this worthwhile education.

THE VEGETABLE ANYBODY CAN GROW, Frank J. Taylor, *Sat. Ev. Post*, April 19, 1958, pp. 41-42, 130-133.

An interesting history of the development of the tomato. As a result of numerous genetic experiments and careful selection of breeding stock we now have tomatoes with improved color and flavor which produce a greater quantity of fruit in a shorter time.

HOW TO SAVE A LIFE, Madelin Alk, *Redbook*, April 1958, pp. 17, 23.

Poisons are common in our homes. Many of them are not regarded as such. What should be done until the doctor comes is most important information. This article could be used effectively to stimulate a discussion of the care of poisonous materials in the home.

WHY YOUR HOSPITAL BILLS ARE TOO HIGH, Ruth and Edward Brecher, *Redbook*, April 1958, pp. 38-41, 105-107.

Are we making the best use of the money spent for hospital care? How can we eliminate waste and cheating, both of which necessarily increase the insurance premium? This is an effective presentation of what is now happening in this branch of healing.

THE SEARCH FOR A CURE FOR CANCER, Dr. Walter C. Alvarez, *Good Housekeeping*, April 1958, pp. 92, 248-250.

A review of known facts about cancer arranged in an easy-to-read outline form.

THE HOT DOG'S BEST FRIEND, Arthur W. Baum, *Sat. Ev. Post*, April 5, 1958, pp. 42-43, 111-112.

Do you like mustard on your hot dog? Is it really mustard? Where does it come from? This is an interesting account of some spices used by humans and their pets and of the family which has done much to develop the condiments we want.

Books

(Continued from page 170)

thor finds facts which completely undermine the complacent materialism of the past century.

Biology and Its Relation to Mankind, Second edition, A. M. Winchester, 902 pp., $7.25, D. Van Nostrand Co., Inc., Princeton, New Jersey, 1957.

The order of presentation in this book succeeds in establishing a most meaningful perspective on biology and its significance for mankind. An introduction to basic biological principles is followed by a thoughtful survey of the plant and animal kingdoms. The human body is thoroughly discussed as a biological organism. New chapters deal with ecology and the distribution of living things on the earth. This book was written for beginning students, not advanced biologists.

The Complete Book of Greenhouse Gardening, Henry T. Northern and Rebecca T. Northern, 353 pp., $6.50, Ronald Press Company, New York 10, N. Y., 1956.

In understandable language and step-by-step illustrations, this comprehensive book unveils "the secret of the green-'house' thumb." Based on the authors' years of experience it tells the gardener everything he needs to know to grow plants to perfection under glass.

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